EFFECTS OF REGIONAL ANTHROPOGENIC GROUNDWATER ALTERATIONS ON GROUNDWATER LEVELS OF THE SAPELO ISLAND COMPLEX, GEORGIA

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Abstract. Widespread water level declines have occurred in the Southeastern Coastal Plain aquifer system, the Upper Floridan aquifer, in response to pumping. This study explores the effects of regional withdrawals from the Upper Floridan aquifer in southeast Georgia on a small undeveloped island, the Sapelo Island complex. A comparison between local (the Sapelo Island complex) and regional (the Southeastern Coastal Plain) anthropogenic groundwater alterations will be presented. Preliminary results show that excessive regional groundwater withdrawal could cause significant declines in the groundwater levels of the Sapelo Island complex.

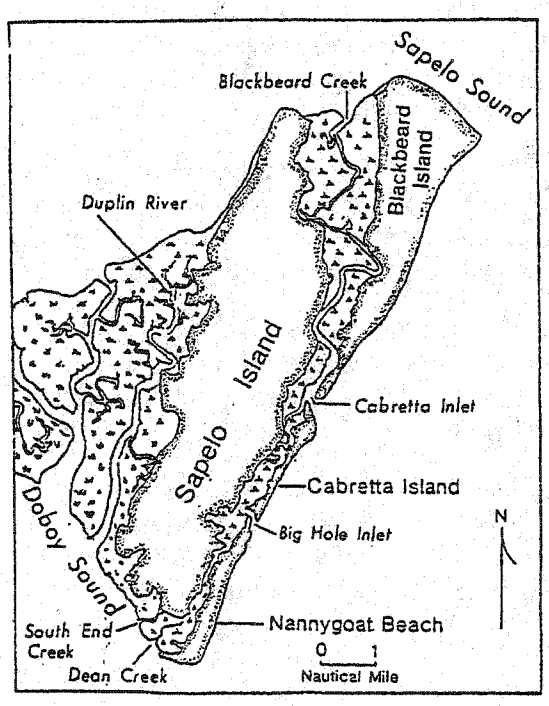

Figure (1): Map showing the Sapelo Island complex (from Hoyt, 1968).

INTRODUCTION

While abundant, the freshwater resources are unfortunately not unlimited. Heavy human usage has led to localized reductions in the aquifer. Current potentiometric maps of the water levels in the Upper Floridan aquifer indicate a general reduction of potentiometric surface (water-level contour) throughout Georgia's southeast region.

The Upper Floridan aquifer in the coastal area is influenced primarily by pumping for municipal and industrial uses and not by recharge from local precipitation (Clarke et al 1990). As a result of this pumping, cones of depression have developed in the potentiometric surface at big industrial cities along the Georgia coast, and widespread water-level declines have occurred in other small and unpopulated areas.

This paper explores the effects of excessive regional groundwater pumping on the groundwater levels of small, undeveloped, and unpopulated island in Georgia – the Sapelo Island complex.

SITE DESCRIPTION

The large barrier island system designated as Blackbeard and Sapelo Islands (referred to here as the Sapelo Island complex) is approximately 19.0 km (11.9 mi.) long and 7.6 km (4.7 mi.) wide (Figure 1). It is separated from St. Catherines Island to the north by Sapelo Sound, from Wolf Island to the south by Doboy Sound, and from the mainland by the Duplin River and a broad expanse of marsh. The larger Holocene beach ridge island of this system is Blackbeard Island, separated from St. Catherines Island by Sapelo Sound and from Sapelo Island by Blackbeard Creek and Cabretta Inlet. The length of the island is 10.3 km (6.4 mi.) and a maximum width of 3.2 km (2 mi.). There are 7,628 ha (18,840 acres) on Sapelo Island, of which 4,689 ha (11,589 acres) are high ground. Some 81-121

ha (200-300 acres) are developed (U.S. Dept. of Interior, 1980). There is limited utilization of the island and much of it is classified as wilderness (Warner and Strouss, 1976).

BACKGROUND AND RELATED WORK

One human influence that is of special significance in planning future development is depletion of the artesian water supply. Although the Coastal Plain (principle artesian) aquifer is a very productive water source, heavy industrial withdrawal from it in the coastal area has caused a serious decline in artesian pressure (Warren 1944, Counts and Donsky 1963).

The water-bearing stratum is confined between impervious strata. The water is under pressure causing it to rise to varying heights in wells tapping the aquifer, depending upon the artesian pressure. A significant decline in the elevation of the potentiometric surface in the coastal area is well-documented (Warren 1944, Counts and Donsky 1963, Callahan 1964) and is mapped in Figures (2) and (3). If withdrawal is very great in a locality, the elevation of the potentiometric surface is severely depressed locally, creating a 'depression cone'.

Three cones of depression are evident along the Georgia coast, centering about Savannah, Brunswick, and the St. Marys-Fernandina beach area. The foci of these depressions are the pumping sites (wells) of major industries. Originally, the potentio-metric surface at Savannah was 1.2 m (40 feet) above sea level, but by 1960 it had receded to 4.8 m (160 feet) below sea level (Johnson et al. 1971).

Reduction of artesian pressure of aquifers in coastal areas creates a hazard of saltwater encroachment into the aquifer. Saltwater may encroach directly from the sea or from ancient saltwater strata below the freshwater aquifers. Both types of saltwater encroachment are occurring near Savannah (McCollum and Counts 1964), and the latter type of encroachment is occurring at Brunswick (Wait 1962).

Geologists pointed out that a decline in elevation of the potentiometric surface is accompanied by an increase in recharge rates and reduced loss from wild-flowing artesian wells (Callahan 1964). They calculated that at 1962 rates of withdrawal, Savannah's water supply will not be endangered by saltwater intrusion for about 90 years (McCollum and Counts 1964). However, the rate of pumping has approximately doubled since 1962.

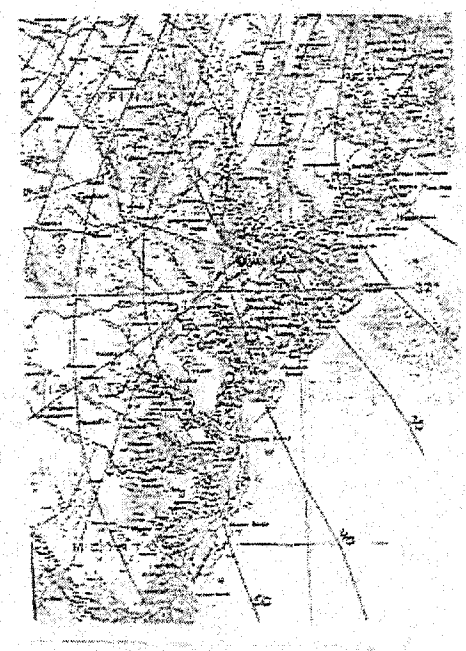

Figure (2): Estimated potentiometric surface for the tertiary limestone (Floridan) aquifer system, Southeastern United States, prior to development. (Adapted from Johnston et al., 1980). Units = Feet

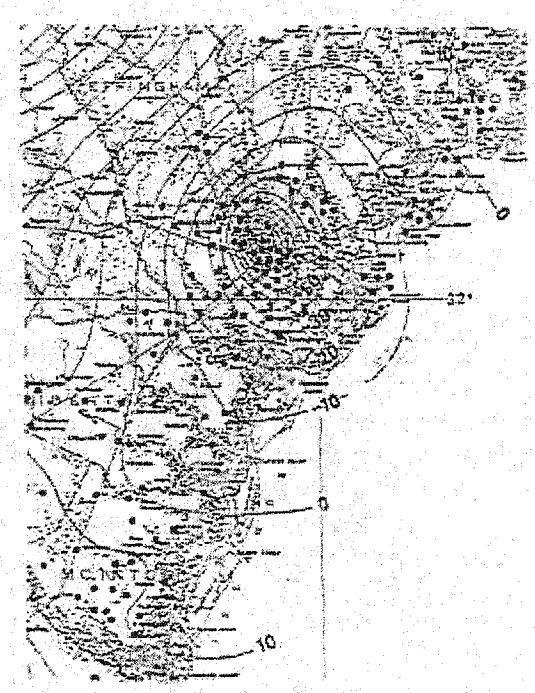

Figure (3): Potentiometric surface for the tertiary limestone (Floridan) aquifer system, Southeastern United States, May 1980. (Adapted from Johnston et al., 1981). Units = Feet

Despite the assurances of geologists that the decline in artesian pressure does not constitute an immediate and pressing problem, the fact remains that even present levels of withdrawal are affecting the entire aquifer, and as additional areas on the coast developed, the problem will become more acute.

WHAT ARE THE EFFECTS OF REGIONAL GROUNDWATER WITHDRAWAL ON GROUNDWATER LEVELS OF SAPELO ISLAND?

Heavy pumping in certain areas had reduced water pressure dramatically and created significant cones of depression (Clark et. al. 1990). The major coastal depression is centered on the City of Savannah, where water levels have decreased from an estimated 1.2 m (40 feet) above sea level prior to development (Figure 2) to approximately 4.5 m (150 feet) below sea level in the center of the cone (Figure 3) (Johnston et al. 1981).

Widespread water-level declines have occurred in the southeastern Coastal Plain aquifer system in response to pumping (Figures 4 and 5), which began about 1900 and by 1985 was about 495 Mgal/d (Miller 1986). The aquifer system has adjusted to pumpage by a combination of increased inflow, decreased outflow, and a reduction in the amount of water in storage. The monthly mean water levels shown in hydrographs for the period of record for both wells in Chatham County (e.g. Savannah) and McIntosh County (e.g. the Sapelo Island complex) indicate a significant decline. These data were collected for the Upper Floridan aquifer.

Conversely to the general trend of population growth along the Georgia eastern coast, the Sapelo Island complex has encountered a decrease in the population of Hog Hammock community, the island's main permanent residents, from about 560 in 1910 to about 50 in 1994. This decreasing population trend appears to have contributed to the reduction in surface and groundwater anthropogenic alterations on the island.

There is no significant industrial or municipal groundwater withdrawal on the Sapelo Island complex, yet there is a major decline in the groundwater levels, during the same period of time. The impacts of excessive groundwater withdrawal in large, populated, and industrial cities sharing the same Floridan aquifer, on the groundwater levels in the Sapelo island complex have become evident as follows (Alkaff 1997):

i. declining elevation of potentiometric surface,
ii. decreasing groundwater levels,
iii. increasing numbers of shrinking ponds, and
iv. experiencing land subsidence (sinking of the ground surface).

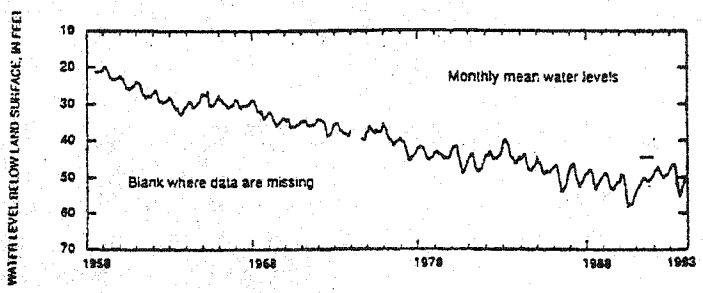

Figure (4): Water level in Upper Floridan observation well 36Q020, Chatham County. (From Joiner and Cressler, 1994).

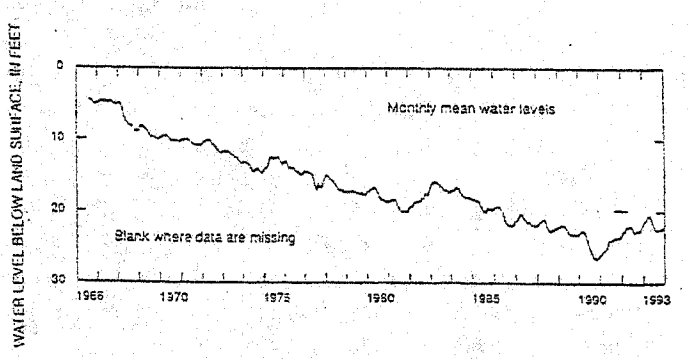

Figure (5): Water level in Upper Floridan observation well 35M013, McIntosh County. (From Joiner and Cressler, 1994).

As "everything is connected to everything else", the groundwater of the Sapelo Island complex is greatly affected by disturbances occurring somewhere else. A better understanding of such connections can only be achieved by looking at the regional and landscape-level system.

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